REVIEW OF THE PRODUCTION MODEL ANALYSES OF BIGEYE *TUNA* (*THUNNUS OBESUS*) IN THE INDIAN OCEAN

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SUMMARY

The catch of bigeye tuna in the Indian Ocean is drastically increasing in recent years and so far analyses by production models have been conducted. The analyses by ASPIC and/or ASPM have been conducted for stock assessment, and those by VPA and/or MULTIFAN-CL have not been used because of insufficient size data. However, there are several problems in the stock assessment by such production models. One thing is that only longline CPUE is utilized as a tuning index for production models. Also, large difference of estimation of MSY is observed between ASPIC and ASPM. ASPM seems to reflect the reality better than ASPIC in that age specific selectivity is included. However, the results of ASPM have several problems, such as very high B-ratio. Other methods like VPA are not available because of insufficient size data and so on. Therefore, it is necessary to use some production models in the stock assessment studies of bigeye tuna in the Indian Ocean.

1. INTRODUCTION

The catch of bigeye tuna in the Indian Ocean has been increasing drastically in recent years (Fig. 1) that urge reliable stock assessments of this species. Because there are not sufficient size data to conduct the age (or size) structured stock assessment such as VPA, MULTIFAN-CL, etc, production model analyses (PM) have been primarily conducted in the past. In this brief paper, we review several PM, which are the surplus-production model analyses (ASPIC) by Miyabe and Suzuki (1991), Okamoto and Miyabe (1996) and Matsumoto (2000) and the age structured production model (ASPM) analyses by Hsu and Liu (2000), which use age specific selectivity. We discuss in this paper some of major problems in these studies.

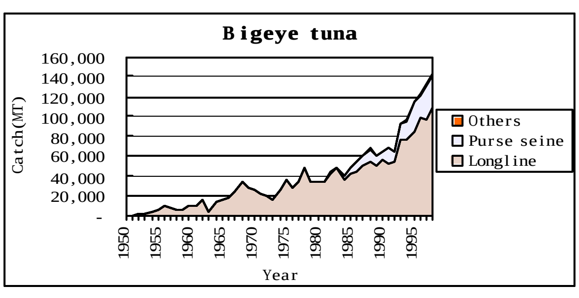

Fig. 1 Trends of BET catch in the Indian Ocean by type of gear.

2. GENERAL REVIEW

We compare three reports dealing with production model analyses of bigeye tuna in the Indian Ocean. Okamoto and Miyabe (1996) and Matsumoto (2000) applied the ASPIC. They used standardized Japanese longline CPUE trends estimated by GLM. On the other hand, Hsu and Liu (2000) applied the ASPM using Korean, Chinese (Taiwanese) and Japanese standardized longline CPUEs. The comparison of the results of these production model analyses is summarized in MSY values estimated by ASPIC are similar between two reports, while estimated MSY by ASPM is much greater than those by ASPIC.

Such discrepancies are caused by 'different model' and/or 'different CPUE series'. CPUE standardization of the Japanese report is different from the Taiwanese report. The former includes the information of fishing gear (deep/regular longline), which is considered to be one of most significant factors creating differences in estimations. In addition, there is heterogeneous in CPUE trend among different longline countries. This heterogeneous requires further study for whether it is artificial or not.

Table 1 ***Comparison of the results of production model of bigeye tuna stock in the Indian Ocean.***

Parameter	Okamoto and Miyabe (1996)	Matsumoto (2000)	Hsu and Liu (2000)
Model	ASPIC	ASPIC	ASPM
CPUE used*	Japan LL	Japan LL	Korea, Taiwan and Japan LL
MSY	32,000-77,000 MT	45,700-74,930 MT	115,890 MT
r	0.0057 and 0.058-8.50	0.111-0.289	
q	1.00E-04 - 8.10E-02	6.08E-06 - 8.92E-06	
K	20-32 and 812,000-3,100,000 MT	1,037,000-1,655,000 MT	
B-ratio (Year compared)	0.90-1.72 and 6.24 (1994)	0.85-0.98 (1998)	>39 (1995)
F-ratio ratio (Year compared)	0.46-2.28 and 3.04 (1994)	1.84-3.40 (1998)	0.42 (1995)

*LL: Longline

The common problem concerning these production models is that only CPUE trend of longline fishery is applied. In recent years catch of purse seine fishery is increasing drastically (Fig. 1), but standardization of purse seine CPUE is very difficult. Recently there are several studies of purse seine CPUE standardization using equipment data for yellowfin and skipjack (Matsumoto *et al.*, 2000, Shono *et al.*, 2000, Soto *et al.*, 2000), but there are no studies for bigeye tuna because of largely bycatch number of bigeye in the purse seine fisheries. Age structure of purse seine catch is quite different from that of longline catch.

TECHNICAL REVIEW

As purse seine catch of juvenile bigeye has been increasing in recent years. The age structure of bigeye tuna catch drastically changed. In order to take account this, ASPM was applied (Hsu and Liu, 2000). In this section, we mainly mention the technical problem and checkpoint in the analysis by ASPM. This method is very convenient because we can get the estimated number at age without catch at age. However, we must pay attention to the several points when applying. These are as follows:

Selectivity

We need to assume the vector of selectivity based on fishery information. If the age structure of catch (or estimated number) changes drastically, then it should be incorporated in the ASPM Furthermore, It should be checked if there is any significant difference between assumed and actual selectivity.

Relationship between CPUE and effort

Fundamental assumptions for the production model consist of the inverse relationship between CPUE and effort with high contrast. We need to check the trend of CPUE and effort. If the effort increases (or decreases) although CPUE decreases (or increases) as a whole, then it is difficult to get the good estimated value of parameters. This condition is applicable not only to ASPM but also to other production models including ASPIC. This requires further check of CPUE and effort series.

Concerns were expressed for the analysis of ASPM by Hsu and Liu (2000) (IOTC, 2000). However, the results (i.e. estimated parameter and indicator) are not realistic, e.g. very high B-ratio. This is probably due to above two problems, especially the assumption of selectivity pattern. In addition, their calculation of standardized CPUE seems to be not adequate because of using Type 1 error. It is more preferable to use Type 3 (or Type 2) error on the basis of a full (i.e. complicated) model in the GLM analysis of SAS/STAT package.

Therefore, despite the application of ASPM seemed to be better reflecting the reality than ASPIC, results of ASPM analysis seemed to be rather problematic. To check in detail about assumption of model, constraint of calculation are necessary and Important in the analysis of such production model.

CONCLUSION

As is mentioned in this paper, there are several problems in production models. There are several methods for more accurate analyses, for example, to use another method such as VPA, MULTIFAN-CL, or tagging, or to improve production models and their input data. But now, sufficient size data necessary for VPA or MULTIFAN-CL are not available. Large scale tagging program is most promising way to improve understanding of stock condition. However, there is some difficulty to secure this fund. While it is necessary to try to get the tagging fund, taking into account these situations, stock assessment by production models will be necessary to be continued for the moment.

REFERENCES

HSU, C. C. AND LIU, H. C. 2000. The current status of bigeye tuna (*Thunnus obesus*) in the Indian Ocean by a stochastic age-structured production model based on longline fishery data. IOTCWPTT-00-25. 26pp.

IOTC. 2000. Report of the second session of the IOTC working party on tropical tunas.

MATSUMOTO, T. 2000. Preliminary stock assessment of bigeye tuna in the Indian Ocean by a non-equilibrium production model. IOTCWPTT-00-09. 8pp.

MATSUMOTO, T., M. OGURA, N. MIYABE AND H. SHONO. 2000. Creation of a database to identify factors affecting CPUE of the Japanese equatorial purse seine fishery. SPC/SCTB13/RG-7.

MIYABE, N. AND Z. SUZUKI. 1991. Stock analysis of bigeye and yellowfin tunas based on longline fishery data. IPTP TWS-90-59. 84-90.

OKAMOTO, H. AND N. MIYABE. 1996. Updated standardized CPUE of bigeye caught by the Japanese longline fishery in the Indian Ocean, and stock assessment by production model. IPTP Collective Volume. No. 9. 225-231.

SHONO, H., T. MATSUMOTO, M. OGURA AND N. MIYABE. 2000. Preliminary analysis of effects of fishing gears on catch rate for the Japanese purse seine fishery. SPC/SCTB13/RG-3.

SOTO, M., J. MORÓN AND P. PALLARÉS. 2000. Standardized catch rates for yellowfin (*Thunnus albacares*) from the Spanish purse seine fleet (1984-1995). IOTCWPTT-00-4.